HIGH-BTU PROJECTS USING PRESSURE SWING ADSORPTION ("PSA") TECHNOLOGY

Presented by:

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CEO of Green Gas Energy, LLC

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GREEN GAS ENERGY GROUP

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A.R.C. Technologies Corporation

- **Designs Plants: Landfill Gas Into Pipeline Gas.**

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Green Gas Energy, LLC

- Obtains Landfill Gas Rights/Project Financing.

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3. Physical Separation of Gases by PSA:

- QuestAir or Engelhard/Guild or ARC.

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Landfill	Location	mmscfd Inlet	Since	Owner	Type
Fresh Kills	Staten Island, NY	14.5	1982	GSF	S
Rumke	Cincinnati, OH	9	1986	GSF	PSA
McCarty Road	Houston, TX	8	1987	GSF	S
McCommas Bluff	Dallas, TX	9	2000	E/S	PSA
Johnson County	Shawnee, KS	4.9	2001	STT	S
St.-Thomas	Montreal, Canada	5	2003	EBI	M
Pinnacle Road	Dayton, OH	5.4	2003	DTE	S
Monroeville	Pittsburgh, PA	5	2004	Magellan	M
Valley	Pittsburgh, PA	5	2004	Magellan	M

Key: S = Solvent PSA = Pressure Swing Adsorption M = Membrane

Source: SCS Engineers January 2006 LMOP Conference Presentation.

2 PSA ---- 3 Membrane --- 4 Solvent/Selexol

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- Separates Gases by Molecular Sizes.
- Molecular Sizes Measured in Angstroms:

  - Angstrom = One Ten-Billionth of a Meter.

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- Carbon Dioxide 3.4 angstroms.

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- Think of Many Tiny Wiffle Balls with Surface Holes Having 3.7 angstrom Diameter.
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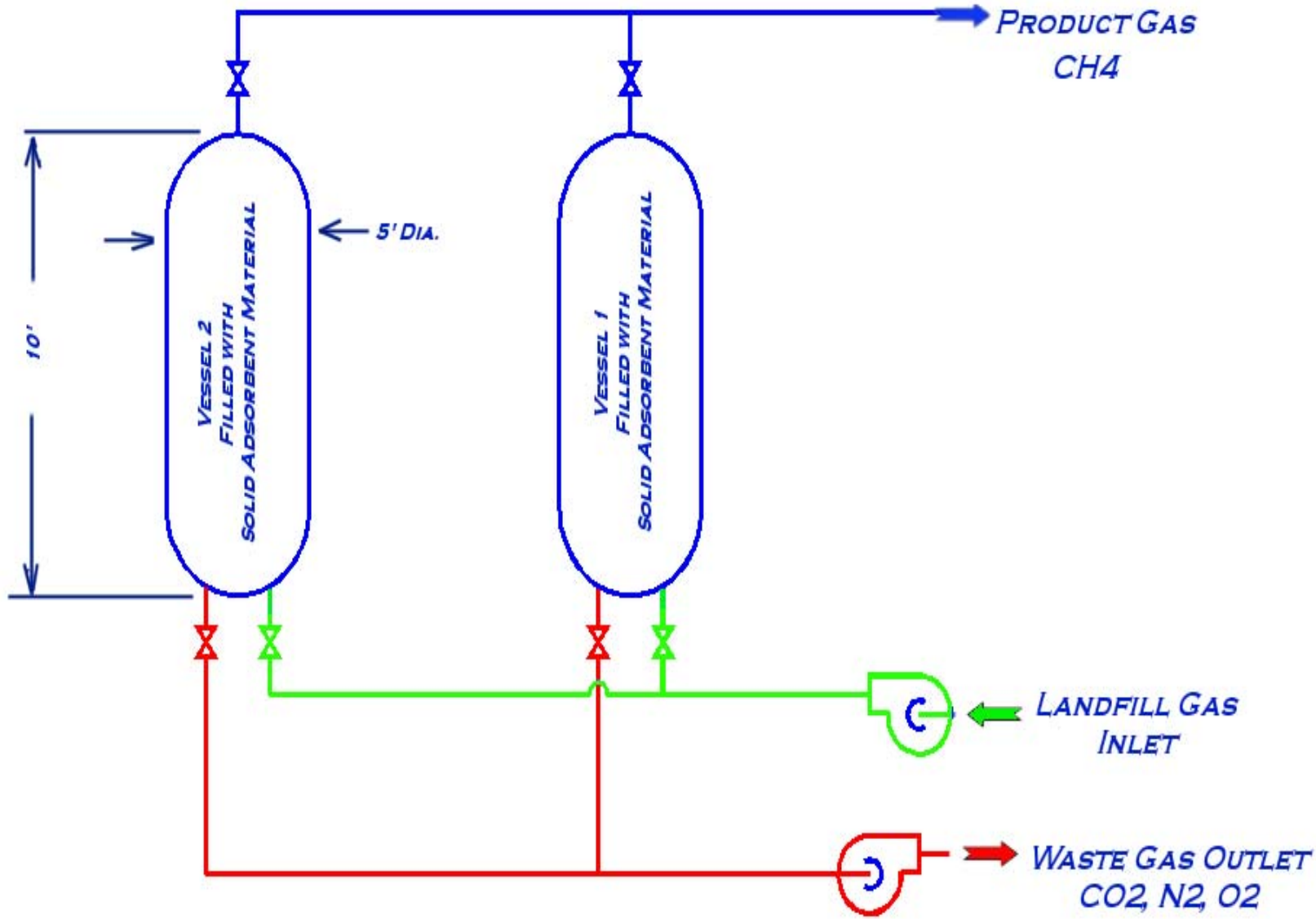
- Non-Methane Gases Go Into Adsorption Material and Methane Gases Pass Through.

PSA FLOW CHART

(AT LEAST TWO PSA VESSELS)


Product Gas
CH4
10'
5' Dia.
Vessel 2
Filled with
Solid Adsorbent Material
Vessel 1
Filled with
Solid Adsorbent Material
Landfill Gas
Inlet
Waste Gas Outlet
CO2, N2, O2

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Step 2: Feed Landfill Gas Into First Vessel Under Pressure:

- Methane will Pass Through the PSA Vessel.
- Smaller Gases will be Drawn Into Adsorbent Material.

Step 3: Shift Landfill Gas Flow to Second Vessel and Draw Vacuum on the First Vessel:

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Step 4: Shift Landfill Gas Back to First Vessel and Draw Vacuum on Second Vessel:

- **Continually Repeat Process.**

- **Thus, the term “Pressure Swing Adsorption”.**

HIGH-BTU PROJECTS

VS.

PIPELINE QUALITY PROJECTS

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- Natural Gas Pipelines Do Not Normally Deviate from their Specifications.

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- O_2 < 0.2%.

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- Most Landfill Gas Separation Technologies Effectively Remove CO_2 But Do Not Significantly Reduce O_2.

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- ARC Full-Scale Plant (1,200 cfm inlet) Operational in Several Months:

  - Two Stage PSA: CO2 Stage & O2/N2 Stage.

  - Control System Adjusts PSA Retention Times.

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- **Possible Section 45 Tax Credits.**